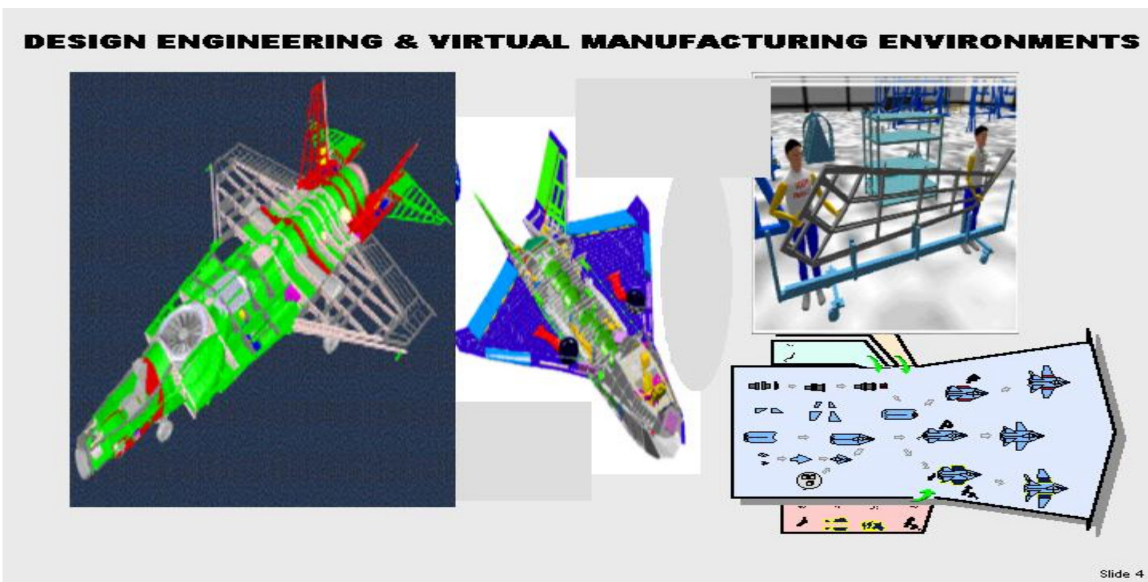
JOINT SYNTHETIC BATTLESPACE: APPLYING SIMULATION TO ACQUISITION, MISSION EFFECTIVENESS, AND COURSE OF ACTION ANALYSIS

INTRODUCTION to SBA. At its essence, SBA is actually a simple concept—using consistently improving simulation and information technology to reduce cost and time to develop systems—while improving the quality of the products. SBA is a DoD acquisition reform initiative envisioning "an acquisition process in which DoD and Industry are enabled by robust, collaborative use of simulation technology that is integrated across acquisition phases and programs." [1] Part of the SBA concept envisions enduring collaborative environments, in which government and/or industry experts utilize off-the-shelf (or minimally modified) sets of reusable, interoperable tools and supporting resources to ***assess the attributes of an emergent capability***, concept, doctrine, tactic, process or situation ***in*** the broader context of ***an expected real-world environment***.[2]

Today, portions of the SBA concept are already part of our acquisition culture: Computer Aided Design & Manufacturing (CAD/CAM) tools are "collaborative environments" that significantly improve the interaction between design and manufacturing engineers. They directly reduce cost and risk across commercial and military systems development.



3D solid modeling and simulation, a common design database for all team engineers, virtual reality and digital simulation of assembly processes allowed the Joint Strike Fighter (JSF) Concept Demonstration Phase assembly to be accomplished with a fifty percent reduction in required staffing levels and time compared to actual planned levels[3]. For JSF or UCAV developments, simulations have dramatically improved mechanical

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[1] DoDD 5000.1, 23 Oct 2000

[2] SBA Definitions, National Defense Industrial Association Systems Engineering Committee & Affordability Task Force of the National Center for Advanced Technologies

[3] Boeing.com/defense-space/military/jsf/lean_mfg.html

tolerances where the originally projected shim stock weight of 40 lbs per aircraft, as in the F-16, was reduced to less than 1 pound.[4] Multiply this single savings example across the procurement of a few thousand aircraft and the potential impact of expanding this concept to the many other areas of design and manufacturing is readily apparent.

Now imagine that instead of manufacturing and design engineers collaborating through the use of CAD/CAM, we begin collaborating engineers, testers, technologists and warfighters through a common simulation framework, called the Joint Synthetic Battlespace—a realistic environment for engineering and testing new warfighting concepts.

JSB. Today, industry and government are positioning to implement just such an approach with simulations focused upon creating <u>collaborative and realistic battlespace environments</u>. The <u>warfighter flies combat missions with design engineers, testers and technologists directly participating</u>. This "collaboration" allows designers to evaluate sensor integration, system interoperability and performance against threats in realistic scenarios or "vignettes" using warfighter developed tactics. The concept can be used to ***assess and prioritize technology investments, make test an integral aspect of design, realize more cost-effective live test, and allow effective/comprehensive testing where live testing is impractical***.

[4] Building A Business Case for M&S, Acquisition Review Quarterly—Fall 2000

Now consider, based upon this approach, that the warfighter begins to define requirements, not with a traditional Operational Requirements Document (ORD), but based upon expected performance in a multitude of scenarios or vignettes implemented within this JSB. Each vignette defines target, threat, terrain, weather and friendly force conditions. The warfighter could establish the mission capabilities of the weapon system, munition, sensor or C2 system and evaluate these capabilities with the designer, technologist and tester within validated simulations well before production or fielding commitment. Essentially, such an approach creates a performance or capabilities based requirements definition of the system. The **expected performance becomes defined** within the context of one or many tactical scenarios or vignettes **as a "mission capability"—*tangible performance parameters would now be measured and made contractually binding, verified in a simulation— validated by selective live testing***.

CHALLENGE. The only major challenge we face to making this work is one of culture and focus. It is possible today to "integrate" existing models and simulations with newly developed synthetic environment simulation architectures and evolve a federation of engineering tools. ***Many of the pieces already exist***. To cohesively bond these pieces together and evolve them simply requires a focused systems engineering effort.

For the concept to be successful it must be embraced by warfighters, program management, engineering and contracting across a government-industry enterprise. Industry is already moving down this path, but they recognize that to succeed requires a government led, disciplined and consistent effort defining the architecture, validating the environment and configuration managing the object representations (weapon systems, muntions, ISR sensors and C2) across government and industry. The good news is that there are many ongoing efforts that can be integrated to establish a common simulation infrastructure . The new AFI 16-1002, M&S Support to Acquisition, already creates a framework for this process. However, program managers need a consistent definition of the "synthetic battlespace" focusing their role of interfacing authoritative representations of weapon systems, munitions, ISR sensors and C2 systems within this JSB.

JSB EXPERIMENT. To implement this framework and create a focus for program managers across government and industry, AFMC is moving forward with a JSB experiment. The work for this is primarily being accomplished by an ad hoc "IPT" created from members of AFMC, AFAMS/XOC and a team of warfighter representatives from AC2ISRC. The planning for this event has been ongoing since the Fall of 2000. It is expected that *a detailed draft simulation architecture and experiment plan will be completed by March 2001* focused upon a "Precision Engagement" Joint Mission Area addressing an end-to-end kill chain—a Time Critical Targeting (TCT) tactical scenario or vignette. The *effort will create a "leave behind" simulation architecture for future experiments*, and a proof of concept for how we should use advanced simulation technology to examine a wide range of C2ISR, Space, Air Vehicle and Munition Family of System trade studies. The JSB architecture should incorporate both constructive and virtual (warfighter-in-the-loop) simulations. The Experiment is envisioned as only the first step in a spiral development process to evolve simulation capabilities suitable for immersing warfighters and engineers, with validation necessary to address engineering needs across a wide range of the acquisition community.

ROAD AHEAD. Actual implementation of this effort beyond planning will require resources and commitment across AFMC. The specific resource requirements will be addressed in the planning documents currently under development. A detailed concept of operations document, that goes far beyond the scope of this paper, is also in development. This detailed "Acquisition Concept of Operations for JSB" will address the broad roadmap and business case for implementing an approach to rapidly acquiring a robust "Aerospace" Joint Synthetic Battlespace for Acquisition (JSB-AF Acq). It is worth noting that the concept of JSB-AF Acq is integrally aligned with the "Concept of Operations for Joint Synthetic Battlespace—Air Force" developed by the Air Force Agency for Modeling & Simulation (AFAMS)[5]. JSB-AF Acq will provide capabilities that are expected to benefit the training and operational domains of the JSB being addressed in the AFAMS CONOPS document.

The JSB-AF Acq concept differs in scope from traditional simulation developments only in that the fidelity required for the acquisition community to support systems engineering, test and technology assessment is more demanding than that traditionally required for training, experimentation, wargaming and operations. The intent of JSB-AF Acq is to provide a consistent and disciplined, medium to high fidelity, repeatable and validated simulation architecture to support:

- Enterprise Management[6]
- Developmental Planning[7]
- Capabilities or Effects Based Requirements
- Performance Based Specifications

A JSB Architecture IPT will establish both near-term and long term implementation plans, synchronized with key activities such as the Joint Distributed Engineering Plant (JDEP) and several OSD Joint Test & Evaluation Programs (e.g. JC2ISR JT&E, JCMD JT&E). Use of live flight JTEs and ATD/ACTDs (e.g. Targets Under Trees, Multi-Platform Tracking Exploitation Demo, etc.) will allow live flight events to be more effective and will help to validate the simulation environment. The Command-wide JSB Architecture IPT will evolve from the current ad hoc organizational approach to a formal activity within the AFMC SBA Integration Office. This organization will begin addressing the architecture and validation processes necessary to support a wide range of programs. The effort should be a key enabler for "Enterprise Management" and Development Planning. One major focus will be to work in concert with other Services and Agencies (e.g. Navy, Army, NRO, SIAP S.E.…) to enable a JSB common simulation/stimulation environment supporting future experiments in the JDEP. The JDEP is being established with Service and OSD funding over the next five years to

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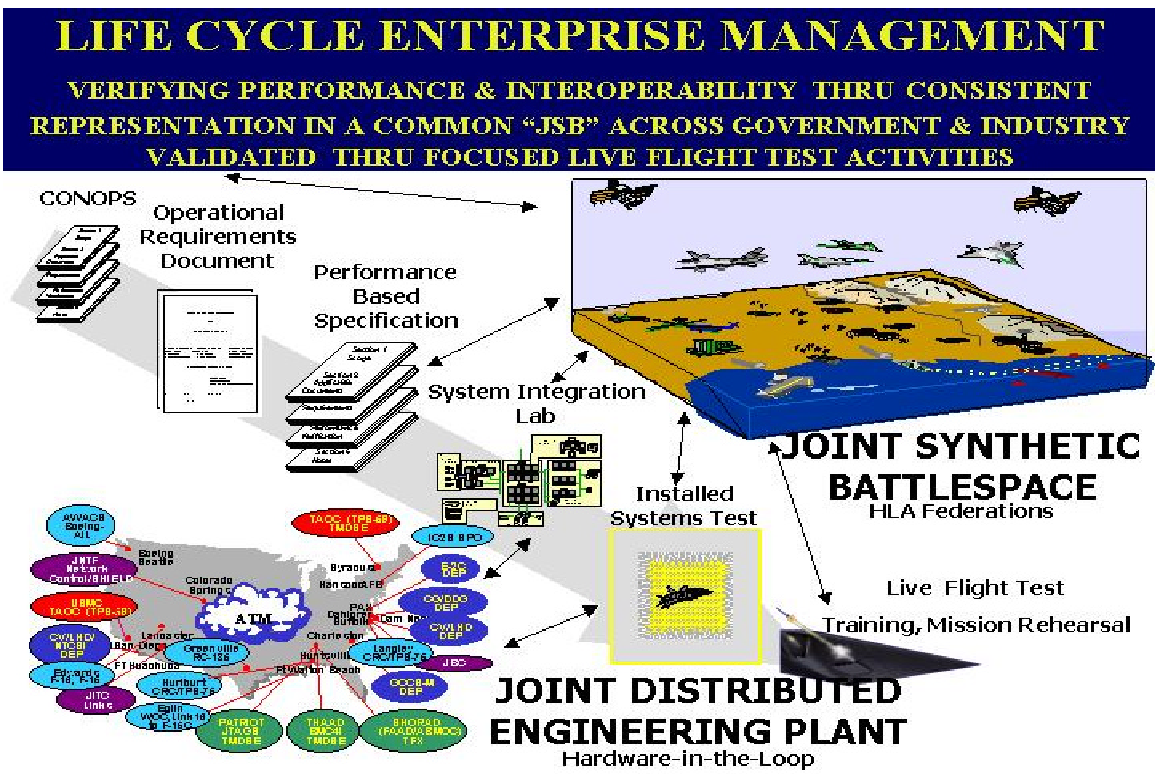
[5] JSB-AF Conops-DRAFT, 1 Jan 2001
[6] Inside the Air Force, 12 Jan 2001, "Lyles: 'Enterprise Management' Would Increase Product Oversight"
[7] Draft Memo: Planning for AFMC Development Planning FOA, 9 Jan 2001

support both simulated entities, warfighter-in-the-loop and hardware-in-the-loop to verify interoperability of new and legacy systems within a family of systems.

VISION. The JSB-AF Acq will provide a consistent, validated, medium to high fidelity environment that will evolve and constantly improve in a manner appropriate to <u>support the systems engineering process, acquisition strategy and business practices across industry and government</u>. The JSB-AF Acq will enable use of performance based specifications and contracting for mission capabilities in a system. It will provide a level playing field across industry and government for technology assessment and testing support long before systems are produced. A key aspect of JSB-AF Acq will be improve hardware/software/warfighter-in-the-loop interfaces ***enabling a robust immersion of engineers and warfighters addressing trades throughout the lifecycle of a system necessary to develop affordable family of systems capabilities for the aerospace enterprise***.



SUMMARY. This initiative complies with AFMC Objectives stated in AFI 16-1002: (1.) provide support to PMs to develop and execute their program M&S strategy; (2.) foster the development and maintenance of an M&S infrastructure and related common-use M&S tools useful to the acquisition community which are consistent, valid and interoperable. <u>If we commit to creating a focused activity to systems engineer the JSB concept now, then we will significantly improve the process, culture and tools to benefit every program manager responsible for building warfighting capabilities in the future</u>.

Col Philip Faye/Integrated C2 SPO/4 Feb 01

ATTACHMENT

20 August 2000

Simulation Based Acquisition (SBA) Definition

Introduction

This document clarifies the SBA concept by providing an expanded definition of SBA, jointly agreed to by (1) the Acquisition Council, a component of DoD's Executive Council for Modeling and Simulation (EXCIMS), and (2) the SBA Industry Steering Group, a component of the National Defense Industrial Association's Systems Engineering Committee and the Affordability Task Force of the National Center for Advanced Technologies. It is expected that this definition will evolve through implementation experience.

Concise Definition of SBA

An acquisition process in which DoD and Industry are enabled by robust, collaborative use of simulation technology that is integrated across acquisition phases and programs.

SBA Goals

- Substantially reduce the time, resources, and risk associated with the entire acquisition process
- Increase the quality, military worth and supportability of fielded systems while reducing total ownership costs throughout the total life cycle
- Enable Integrated Product and Process Development (IPPD) across the entire acquisition life cycle

SBA Is

- A dramatically improved acquisition process enabled by the application of advanced information technology (IT); legislation, policy, budgeting and management changes; and the education and motivation of all participants.

- Better informed decisions and reduced risk by more accurate and comprehensive assessments of design, manufacturing, employment and support concepts earlier in the acquisition cycle.

- The optimization of system performance versus total ownership cost (TOC) by early and continuing collaborative exploration of the largest possible trade space: across all of a system's life cycle activities, within and among multiple government and commercial organizations, across professions and disciplines, and up through system of systems mission area perspectives.

- Faster time to field through increased concurrency, tighter decision cycles, more efficient and effective testing, and a reduction in costly fixes for problems discovered late in the acquisition cycle.

- Lower total ownership cost of individual systems via lower personnel and material costs accruing from the above, and from the standards-based reuse of information and software to minimize their cost.

- Greater modernization for DoD through this reduction in the cost of individual systems and the more optimal program investments enabled by system of systems mission area assessments.

- The provision of enduring collaborative environments, in which government and/or industry experts utilize off-the-shelf (or minimally modified) sets of reusable, interoperable tools and supporting resources (such as information sets) to assess the attributes of an emergent capability, concept, doctrine, tactic, process or situation in the broader context of an expected real-world environment.

- The efficient, automated and near-real-time sharing of relevant information among all personnel with a need to know, such that they have accurate and consistent understandings of a system (both physical and behavioral) and its external environments, including their variants, as they evolve. Information about the system is shared via a distributed product description (DPD). Information about its external environments is shared by similar mechanisms. A DPD is characterized by:
    - The integration of information in disparate locations into what appears to the user as a single integrated data set;
    - Minimal data duplication, such that data is created once, but used many times;
    - Data set coherency in terms of semantics, syntax, levels of resolution (granularity), and integrity among interdependent attributes;
    - Web-based access and user-friendly search, display, parsing, download and subscription mechanisms, with alert, trigger and threshold functions to enable delivery of only relevant information (to minimize bandwidth and processing costs, and avoid human overload);
    - Security/access controls to protect classified, proprietary or private information; and
    - Configuration management of multiple versions and their histories, to include analysis results and decision rationales.

- The aggressive, comprehensive application and sharing of mature advancements in information technology such as distributed networking, multi-user computer environments, database management systems and particularly advanced modeling and simulation (M&S) tools, including commercial product development automation tools (e.g., CAD, ERP), HLA-based distributed simulation, and interactive virtual reality. The models and simulations will:
    - Be verified and validated, with documentation of this to facilitate accreditation and reuse;
    - Communicate system concepts and capabilities;
    - Manage the details of complex spatial, causal and temporal relationships, helping humans assess key parameters, identify issues, track trends and assess the merits of alternatives;
    - Allow a system to be designed, built, tested and operated in the computer before critical decisions are locked-in and manufacturing begins;
    - Allow alternative designs to be carried further into the acquisition process;

    - Make test an integral aspect of design, make live testing more cost-effective, and allow effective testing where live testing is impractical; and
    - Collectively satisfy all program needs capable of being addressed via M&S.

- Dependent on the <u>capability to interoperate and reuse heterogeneous tools and digital information</u>, and to incrementally insert technology upgrades and replacements for each, made possible by specifying:
    - Reference operational and system architectures, adaptable to individual programs;
    - A common technical architecture; and
    - Open, preferably commercial, data interchange standards.
- A <u>non-proprietary</u> environment, allowing the use of proprietary tools and information as appropriate.
- An <u>enduring</u> means for understanding, managing and modifying a system throughout its lifetime.
- <u>Dependent on competent professionals</u>, including M&S experts, in both government and industry.

<u>SBA Is Not</u>

- A replacement for good systems engineering.
- Having simulations make the decisions.
- Giving all information to everyone and letting everyone see everything you do.
- The loss of security and proprietary advantage.
- The loss of responsibility, authority and/or accountability.
- Just using M&S in an acquisition program.